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FACT SHEET

CATEGORY: 3.5	MANUFACTURING PROCESSES	SURFACE FINISHING

INTRODUCTION

Various surface finishes are available for a wide variety of materials for a number of: aesthetic or functional reasons. This factsheet presents electroplating, galvanising, electroless nickel plating, plating processes for plastics, vitreous enamelling, anodising and painting.

Electroplating

Electroplating protects, beautifies, insulates or increases the corrosion resistance, conductivity or solderability of metal objects, generally of iron or copper alloys, but sometimes other metals as well. Electroplating is the process of deposition of one metal onto the surface of another by electrolytic action. Metal is taken from the anode (+) and deposited on the cathode (-) through a solution containing the metal as an electrically charged ion.

It is important to understand the different pre-treatment works every metal requires. Aluminium, for example, may dissolve in solutions designed for cleaning steel. Even variation between alloys will require modification of the pre-treatment process. An incorrect identification may result in damage or even the destruction of the parts. Metal preparation is crucial because it affects adhesion and appearance, as well as the composition and properties of the final deposit. Platers need accurate information about material contamination, such as, inclusions in the base metal, cutting oils used and any organic or inorganic surface films. Environmental regulations have severely restricted cleaning options. While the choices are limited, most soils can be safely removed if the platers know what they're dealing with. Information supplied by the customer is the key to successful metal finishing.

Reference: WAYNE Metal Protection Company.

Galvanising

Galvanising is the process of coating iron or steel with a layer of zinc to provide corrosion resistance and so prevent rusting. The components to be galvanised are covered with a flux (usually zinc ammonium chloride) and are immersed in a bath of molten zinc. Hot dip galvanising protects steel as the coating weathers very slowly giving a long and predictable life.

Although Hot Dip Galvanising is simple and effective to use, the metallurgy that goes on during the application process is quite complicated. The galvanised coating forms because iron and zinc react together to form an alloy. As the surface of fabricated steel is often contaminated with rust and oil, the surface must be cleaned prior to the galvanising process. Alloying only takes place if the surface of the steel is clean enough to be wetted by liquid zinc. The steel must be free from grease and rust and this is achieved by *pickling*, a process that removes surface contaminants to obtain a chemically clean surface. The galvanising reaction between zinc and steel takes place in molten zinc at approximately 450°C. The componentfabrication is taken out of the zinc when the reaction is complete, typically after a few minutes, and although the zinc coating has already formed, its internal structure continues to change until the steel returns to ambient temperature. Galvanising does have a finite life and its effectiveness as a barrier depends directly on the thickness of the coating and the environment.

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FACT SHEET

Electroless Nickel Plating

In contrast to conventional electrolytic processes, electroless nickel plating does not use an electric current to produce a deposit, but operates chemically. Deposition will only take place in the presence of a catalyst. The properly prepared basis metal acts as the initial catalyst and since the deposit itself is also a catalyst, the reaction continues autocatalytically. Thus varying deposit thickness via electroless nickel plating can be obtained as long as the reacting chemicals are replenished. Electroless Nickel Plating is sometimes also known as autocatalytic nickel alloy coatings. Electroless Nickel is used because of its unique combination of physical properties, particularly those of hardness and corrosion resistance in aggressive conditions. Electroless nickel gives excellent uniformity of deposition.

Plating Processes for Plastics

Plastics may be coated with metals to provide Electro Magnetic Interference (EMI) screening by a number of methods.

- *Vacuum metallisation*
  Vacuum metallisation has been specifically developed for coating plastic components with a pure aluminium coating to provide high levels of EMI/RFI shielding. It is the most environmentally friendly shielding process, requiring no solvents and producing no harmful by-products. The coatings have a smooth metallic appearance and are highly ductile and adhere to most engineering plastics. The process deposits a pure layer of aluminium (99.8%) and, as aluminium dissolves in sodium hydroxide, parts are easy to recycle. Coatings produced offer considerable weight saving and very high shielding. Parts can be coated selectively using multi-impression masking tools.

- *Conductive paint spraying*
  A wide range of metal-loaded paints are used to provide EMI/RFI protection, although silver or silver-plated copper-loaded paints are the most commonly specified. Historically, all paints contained harsh solvents (usually MEK) to improve adhesion to the substrate. However, the trend towards thin-walled mouldings involving blends of polycarbonate and ABS has amplified the need to minimise the impact of the coating on the substrate. This has resulted in the development of "Safe on Substrate" technologies. These paints are formulated using mild solvents and can be mechanically removed to allow the plastics to be recycled.

- *Electroplating*
  Two types of electroplating process are commonly used for EMI shielding of plastic enclosures: electroless and electrolytic plating. These coatings have the unusual ability to combine aesthetic appeal, wear and corrosion resistance with very high levels of shielding. A nickel layer is chemically or electrically deposited over a layer of pure copper. The process does not lend itself to selective finishing; hence it is usually specified on internal components. For recycling, parts are dipped in an acid solution to remove the plated parts.

Reference: Industrial Technology

Alternative Material Coatings
Other material coatings, their application, benefits and use are discussed by Highland Metals
http://www.higalv.co.uk/platers-home.htm

Created on 18/12/03 12:11

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FACT SHEET

Vitreous Enamelling

Vitreous Enamel is a thin layer of glass fused by heat on to the surface of a metal. Household objects such as baths, ovens and cooker hobs will almost certainly have a vitreous enamel coating. It was the material used to produce the now highly collectable advertising signs produced during the early 20th Century. Vitreous Enamelling is also used in the storage silos on farms. It should not be confused with enamel paint, which does not posses the hardness, heat resistance and colour stability that is only available with real vitreous enamel. The glass is applied to the metal either as a powder or mixed with water. The metal is then heated in a furnace to a temperature between 750 and 850 °C. This 'firing' process gives vitreous enamel its unique combination of properties. The smooth glass-like surface is very hard and is scratch, chemical and fire resistant. It is easy to clean and hygienic.

Vitreous enamel can be applied to most metals. For jewellery and decorative items it is often applied to gold, silver, copper and bronze. For the more common uses, it is applied to steel or cast iron. There are some specialised uses on stainless steel and aluminium. The durability of the early advertising signs, still showing the brilliance of the original colours after a hundred years, is one of the best examples of the long-term colour stability of vitreous enamel.

Anodising

Anodising is one of the most common methods for enhancing the corrosion resistance of aluminium alloy components. It is an electrolytic process that yields a hard, relatively thick film of aluminium oxide on the surface of the aluminium when the metal is made the anode in a suitable electrolyte and current is passed through the circuit. The different types of anodising used commercially are: -

- Sulphuric Acid Anodising
- Integral Colour Anodising
- Chromic Acid Anodising
- Hard Anodising

Other protection methods include chemical conversion coatings and various paint finishes. Chemical pre-treatment prior to painting is essential. Sacrificial anodes, e.g. zinc, can be used to protect aluminium alloy structures when used in marine environments.

Reference: ALFED Corrosion Factsheet

Painting

A layer of paint applied to the surface of a material provides a physical barrier that prevents the material corroding in its environment. Protection is effective until the paint coating is penetrated, either via a pore, a crack or by damage or wear. The substrate will then corrode and the corrosion products, which are generally more voluminous than the parent metal will lift off the remaining paint coating and allow further attack.

It is important to prepare the material surface prior to painting to ensure that the paint adheres properly to the substrate. The presence of oils, grease, dust and in the case of steels, rust will all prevent adhesion. It may be necessary to 'rough up' the surface of the substrate to provide a key for the paint. In many cases a series of layers of paint are used to achieve a good durability.

There are many types of paint that are available including many specialised types. This includes paints where two materials are mixed immediately prior to spraying and they react together to create a hard and chemical-resistant coating. Consultation with paint manufacturers is recommended before choosing a suitable paint finish.

Processes for the application of paint include application by brush, spraying, electrodeposition and dipping. In electrodeposition an electrical charge is used to ensure that adhesion to the base material is excellent. Modern dedicated paint plants may incorporate several techniques for multi-coating and the capital investment can be substantial.

SURFACE FINISH INTERNET RESOURCES

Industrial Technology details information regarding metallic plating of plastic components. http://www.industrialtechnology.co.uk/2001/may/applied.html

Phoenix Electroplating Limited provide hard chrome and nickel electroplating services. http://www.electroplating.co.uk/

Douglas Plating Ltd offers technical notes concerning the electroplating process. http://www.douglas-plating.co.uk/

Bins-n-Benches provide a detailed account of the Hot Dip Galvanisation process. http://www.bins-n-benches.freeserve.co.uk/

The British Electroless Nickel Society details information concerning electroless nickel plating. http://www.sea.org.uk/bensintro.htm

Highland Metals present interesting information pertaining to various surface finishes. http://www.higalv.co.uk/

The Institute of Vitreous Enamellers is the UK based technical Institute for Vitreous Enamelling. http://www.ive.org.uk/

Bodycote Metturgical coatings provide a wide range of coatings for a diverse range of applications. http://mc.bodycote.com/index.asp?ID=74&Section=process

ALFED Corrosion Factsheet provides information on corrosion protection for aluminium alloys. http://www.alfed.org.uk/corrosion.htm

WAYNE Metal Protection Company provides information on special finishes. http://www.waynemetalprotection.com/